

Description of Quadrangle 10 topography excerpted from:

Valentine, P.C., Unger, T.S., and Baker, J.L., 2000, Sun-illuminated sea floor topography of Quadrangle 10 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2710, scale 1:25,000.

Introduction

The Stellwagen Bank National Marine Sanctuary Mapping Project is a cooperative effort of the U.S. Geological Survey and the National Oceanic and Atmospheric Administration, with support from the University of New Brunswick and the Canadian Hydrographic Service. The multibeam echo sounder survey was conducted on four cruises over a two-year period from the fall of 1994 to the fall of 1996. This map shows one of a series of 18 quadrangles (see location map) in which sea floor depth information is depicted in sun-illuminated (or shaded relief) view at a scale of 1:25,000, with topographic contours overprinted in blue. The image shown here uses a sun elevation angle of 45 degrees above the horizon from an azimuth of 350 degrees and a vertical exaggeration of four times. In effect, topographic relief is enhanced by having the sun illuminate the sea floor from a position 10 degrees west of north, so that shadows are cast on the southern flanks of seabed features. Some features in the images are artifacts of data collection. They are especially noticeable where the seabed is smooth, and they include small highs and lows and unnatural-looking features and patterns that are oriented parallel or perpendicular to survey tracklines. For a depiction of the topographic contours alone, and for an explanation of survey and topographic data-processing methods, see the companion map by Valentine and others (1997). Topographic contour maps of all 18 quadrangles in the map series are available on a CD-ROM in EPS, PS, Arc export, and PDF file formats (Valentine and others, 1998). Blank areas represent places where no data exists.

Regional seabed features

The major topographic features depicted in the map series were formed by glacial processes. In broad terms, these features are interpreted here to represent a geologic history that developed in several stages. Ice containing rock debris moved across the region, sculpting its surface and depositing sediment to form the large basins, banks, ridges, and valleys. Many other features observed here represent the latter stages of deglaciation. They are the result of processes at work when much of the area was covered by stationary rotting ice, and when at the same time small valley glaciers and ice falls were active in and near areas of high topographic relief. The sea invaded the region formerly occupied by ice, and seabed features were partly eroded and some new sedimentary deposits formed. Today, the sea floor is modified mainly by strong southwestward-flowing bottom currents caused by storm winds from the northeast. These currents erode sediments from the shallow banks and transport them into the basins. With time, the banks affected by these currents become coarser, as sand and mud are removed and gravel remains; and the western flanks of the banks, as well as adjacent basins, are built up by deposits of mud and sand.

Quadrangle 10 features

The northeastern part of Quadrangle 10 is a smooth, muddy sea floor that slopes eastward and southeastward through water depths of 80 to 120 m. It is part of a large basin (Gloucester Basin) that extends into Quadrangles 11 and 13 (Valentine and others, 2000a,b). A small portion of a

flat-topped bank (Polygon Bank) is present along the northern part of the eastern edge of Quadrangle 10 (42° 33.0' N., 70° 24.8' W.). At the base of this bank are hummocky, lobe-shaped features that extend into the basin. They are interpreted to consist of glacial debris (now covered with muddy sand) which was deposited by ice falls that flowed from the bank above. The smooth basin floor is interrupted by two small, elongate banks (42° 32.0' N., 70° 25.4' W.; 42° 31.2' N., 70° 24.7' W.). They are part of a southeast-trending alignment of small banks that extend into Quadrangle 11 and that reflect the direction of movement of glacial ice in the basin.

Most of the rest of Quadrangle 10, north of approximately 42° 29' N., is a complex of flat-topped banks and elongate, rounded hills of various sizes that are separated by the relatively smooth seabed of basins and valleys. The surfaces of the positive features lie at 45 to 75 m water depth and are gravel that in places is covered with a thin veneer of sand. The elongate, rounded features resemble drumlins and drumlinoid ridges (42° 30.8' N., 70° 35.8' W.; 42° 30.9' N., 70° 34.5' W.) characteristic of glaciated terrain, and their northeastward trend suggests that the ice moved to the northeast in this area. The flat-topped banks are modified by valleys and basins, and by boulder piles and ridges that have a relief of up to 5 m and that are interpreted to be lateral moraines (deposits of rock debris piled up at the edges of moving ice) and eskers (sand and gravel deposited by running water within stationary glacial ice). Lateral moraines are present along many of the upper margins of many valleys (42° 30.4' N., 70° 33.6' W.; 42° 29.6' N., 70° 28.8' W.). Eskers are common on the bank tops and are present as solitary features (42° 29.5' N., 70° 28.2' W.) and as networks of sinuous sharp gravel ridges (42° 33.3' N., 70° 32.8' W.) on Gloucester Bank. The boulder piles and ridges commonly are constructed of boulders and cobbles that now are separated by voids from which sand and small gravel presumably were eroded during advance of the sea after the glacial ice melted. The seabed in the basins and valleys on the banks and around the margins of the banks and elongate, rounded hills is muddy sand; the deep parts of the basins and valleys that separate the banks are sandy mud.

A deep valley floored with sandy mud is present in the southeast corner of the quadrangle. It extends northwestward through water depths of 85 to 105 m and turns north to form a narrow basin (Stenos Basin at 42° 29.5' N., 70° 27.2' W. bounded by two banks (including Ellipse Bank to the west) whose steep flanks have a relief of 60 m. The basin floor reaches a depth of 125 m and its hummocky surface possibly represents gravelly debris (now covered with muddy sand) that was transported by glacial ice. A low ridge across the basin floor (42° 28.7' N., 70° 27.2' W.) resembles an end moraine deposited by the forward edge of glacial ice that occupied the southern part of the basin. The large bank located along the southeastern edge of the quadrangle is dissected by valleys (42° 27.8' N., 70° 25.4' W.) that extend into the adjacent Quadrangle 11 to the east. The valley floors are muddy sand, and the bank surface is gravel, including boulder piles and ridges. The gravel is covered in places with a thin veneer of sand that is more extensive on the valley sides and in the shallow depressions on the bank surface.

The southern part of the quadrangle, south of approximately 42° 29' N. and west of 70° 27' W., is occupied by the northern part of a large, relatively flat bank (Lower Stellwagen Bank) that lies at a water depth of 50 to 65 m. The bank surface is gravel and contains scattered boulder piles, as well as ridges that largely represent eskers. Shallow, irregularly shaped depressions in the sea floor (42° 27.4' N., 70° 28.8' W.), in association with gravel ridges, possibly represent the former locations of large masses of melting glacial ice. The bank margin is incised by shallow valleys

whose floors are covered with muddy sand. However, a small basin in the interior of the bank (42° 28.3' N., 70° 30.7' W.) is floored with sandy mud. Sand with a gullied surface (42° 29.0' N., 70° 30.8' W.) covers the flank of a valley on the northern part of the bank. A sand deposit also is present on the southeasternmost part of the bank (42° 26.8' N., 70° 27.4' W.). The sand exhibits shallow downslope gullies, and has been transported here from the northern edge of Stellwagen Bank that lies at a higher level to the south in the adjacent Quadrangle 7 (Valentine and others, 1999a).

In the southwestern part of Quadrangle 10, the surface of the gravel bank is separated from a deep muddy basin (Stellwagen Basin) to the west by a northwest-trending escarpment 30 m high. The basin floor deepens northward from 85 m at the foot of the bank to 105 m in a small elongate basin (42° 28.0' N., 70° 35.5' W.) at the mouth of a valley that incises the bank edge. A small, southeast-trending drumlin is present in the southwest corner of the quadrangle. Farther north, along the western edge of the quadrangle, the smooth, almost flat mud floor of the basin is interrupted by shallow depressions that are elliptical moats surrounding a central mound (42° 29.4' N., 70° 35.75' W.). The depressions range up to several hundred meters in length, and observations of similar features in Quadrangles 7 and 8 (Valentine and others, 1999a,b) have shown the mounds to be patches of gravel, including boulders, that are frequented by groundfish. Some boulders and smaller gravel are exposed in the bottom of pits in the mud in which fish are present. The depressions are interpreted to have been formed by the scouring actions of groundfish that have exposed the gravel habitat and prevented its burial by basin mud.

REFERENCES CITED

- Valentine, P.C., Unger, T.S., Baker, J.L., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 10 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-683, scale 1:25,000.
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- Valentine, P.C., Baker, J.L., and Unger, T.S., 2000a, Sun-illuminated sea floor topography of Quadrangle 11 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2711, scale 1:25,000.
- 2000b, Sun-illuminated sea floor topography of Quadrangle 13 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2713, scale 1:25,000.